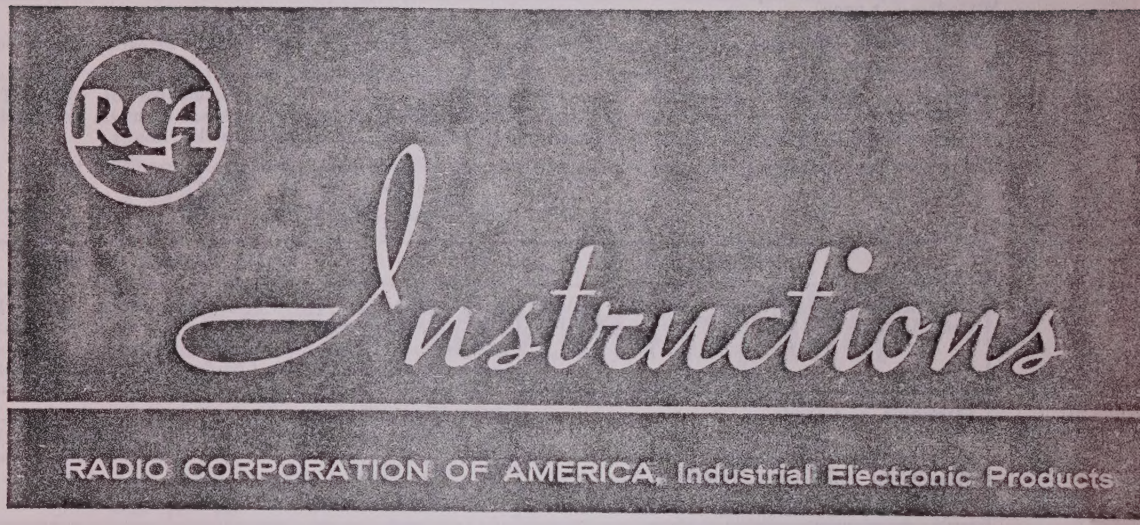
RCA TYPE BA-33A

TRANSISTOR PROGRAM AMPLIFIER

MI-11446

BROADCAST AUDIO EQUIPMENT



Type BA-33A

Transistor Program Amplifier

MI-11446

IB-24820-1

EQUIPMENT LOST OR DAMAGED IN TRANSIT

When delivering the equipment to you, the truck driver or carrier's agent will present a receipt for your signature. Do not sign it until you have (a) inspected the containers for visible signs of damage and (b) counted the containers and compared with the amount shown on the shipping papers. If a shortage or if evidence of damage is noted, insist that notation to that effect be made on the shipping papers before you sign them.

Further, after receiving the equipment, unpack it and inspect thoroughly for concealed damage. If concealed damage is discovered, immediately notify the carrier, confirming the notification in writing, and secure an inspection report. This item should be unpacked and inspected for damage WITHIN 15 DAYS after receipt. Report all shortages and damages to RCA, Broadcast and Television Department, Camden 2, N. J.

Radio Corporation of America will file all claims for loss and damage on this equipment so long as the inspection report is obtained. Disposition of the damaged item will be furnished by RCA.

REPLACEMENT PARTS AND ENGINEERING SERVICE

RCA field engineering service is available at current rates. Requests for field engineering service may be addressed to your RCA Broadcast Field Representative or the RCA Service Company, Inc., Broadcast Service Division, Camden, N. J. Telephone: WOodlawn 3-8000.

When ordering replacement parts, please give symbol, description, and stock number of each item ordered.

The part which will be supplied against an order for a replacement item may not be an exact duplicate of the original part. However, it will be a satisfactory replacement differing only in minor mechanical or electrical characteristics. Such differences will in no way impair the operation of the equipment. Parts with no stock numbers are standard components. They are not stocked by RCA and should be obtained from your local electronic parts distributor.

The following tabulations list service parts and electron tube ordering instructions according to your geographical location.

SERVICE PARTS

LOCATION	ORDER SERVICE PARTS FROM:
Continental United States, including Alaska and Hawaii	RCA Parts and Accessories Department, P.O. Box 654, Camden, New Jersey or through your nearest RCA Regional Office. Emergency orders may be telephoned, telegraphed, or teletyped to RCA Emergency Service, Bldg. 60, Camden, N. J. (Telephone: WO 3-8000).
Dominion of Canada	RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec or through your local Sales Representative or his office.
Outside of Continental United States, Alaska, Hawaii and the Dominion of Canada	RCA International Division, Clark, N. J., U.S.A. or through your local Sales Representative.

ELECTRON TUBES

LOCATION	ORDER ELECTRON TUBES FROM:
Continental United States, including Alaska and Hawaii	Local RCA Tube Distributor.
Dominion of Canada	RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec or through your local Sales Representative or his office.
Outside of Continental United States, Alaska, Hawaii and the Dominion of Canada	Local RCA Tube Distributor or from: Tube Department RCA International Division 30 Rockefeller Plaza New York 20, New York, U.S.A.

RETURN OF ELECTRON TUBES

If for any reason, it is desired to return tubes, please return them through your local RCA tube distributor, RCA Victor Co. Ltd., or RCA International Div., depending on your location.

Please do not return tubes directly to RCA without authorization and shipping instructions.

It is important that complete information regarding each tube (including type, serial number, hours of service and reason for its return) be given. When tubes are returned, they should be shipped to the address specified on the Return Authorization form. A copy of the Return Authorization and also a Service Report for each tube should be packed with the tubes.

LIST OF RCA SALES OFFICES

Atlanta 3, Georgia
1121 Rhodes-Haverty Bldg.
134 Peachtree St. N.W.
JAckson 4-7703

Boston 16, Mass.
Room 2301, John Hancock Bldg.
200 Berkley St.
HUbbard 2-5765

Camden 2, N. J.
Building 15
WOodlawn 3-8000

Charlotte 4, N. C.
504 Charlottetown Mall
333-3996

Chicago 54, Ill.
1186 Merchandise Mart Plaza
DElaware 7-0700

Cleveland 15, Ohio
1600 Keith Bldg.
CHerry 1-3450

Dallas 35, Texas
7901 Empire Freeway
FLeetwood 2-3911

Detroit 39, Mich.
12605 Arnold St.
KEnwood 4-5100

Hollywood 28, Calif.
RCA Bldg., 1560 N. Vine St.
HOllywood 9-2154

Indianapolis, Ind.
501 N. LaSalle St.
MElrose 6-5321

Kansas City 15, Missouri
7711 State Line Road
EMerson 1-6770

New York 20, New York
36 W. 49th St.
JUdson 6-3800

Paterson, N. J.
495 E. 30th St.
MUlberry 4-0972

Portland 5, Oregon
1208 S.W. 14th St.
CApitol 6-6828

San Francisco 2, Calif.
420 Taylor St.
ORdway 3-8027

Seattle, Washington
2250 First Ave., S.
MAin 2-8350

Washington 6, D. C.
1725 K St., N.W.
FEderal 7-8500

INSTRUCTIONS

Type BA-33A

Transistor Program Amplifier

MI-11446

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-24820-1

PRINTED IN U.S.A.
WA 6101

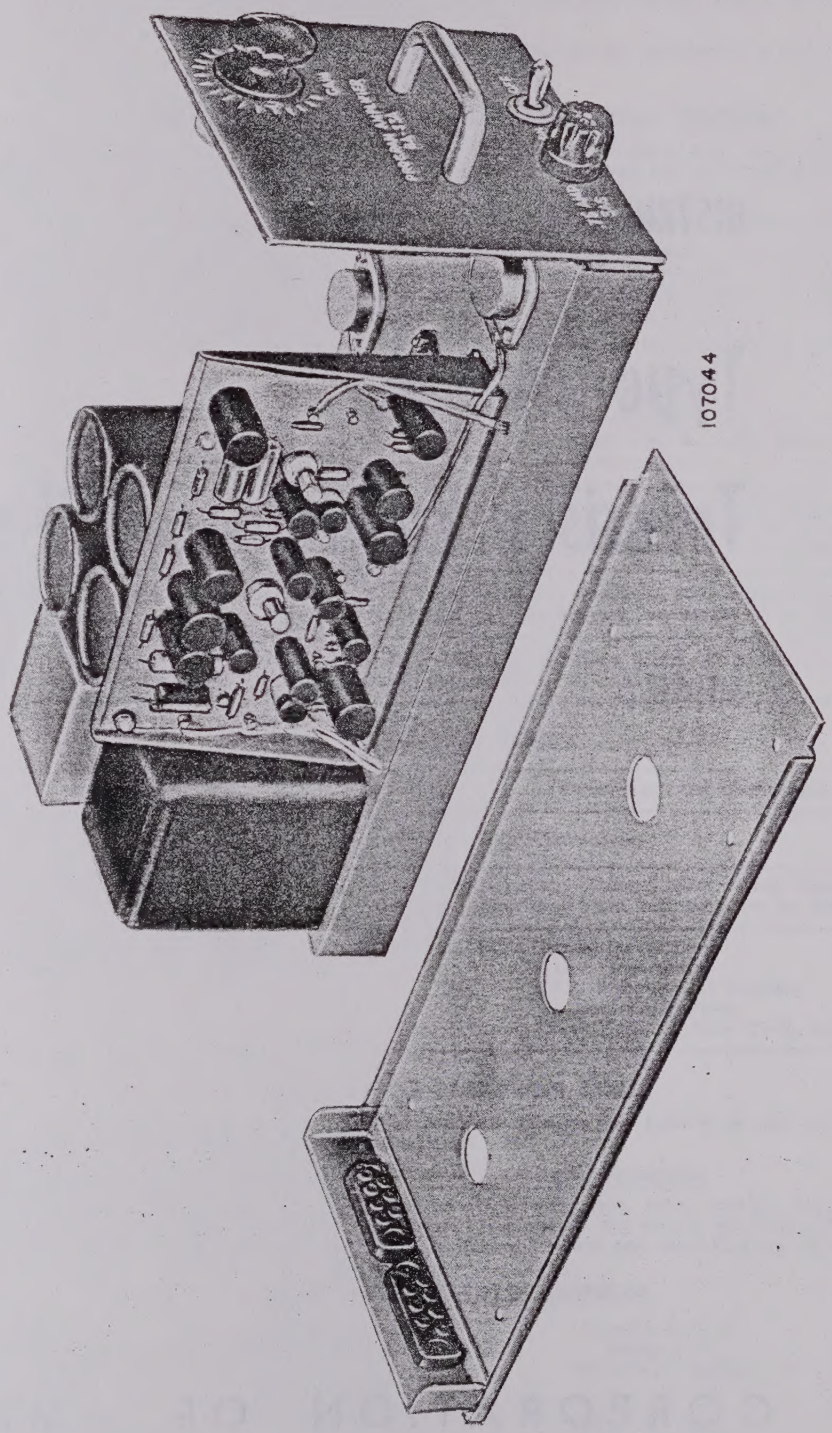


Figure 1—BA-33A Program Amplifier MI-11446 with Guide Assembly

TECHNICAL DATA

Power Required

117 volts AC 50/60 cycles with taps at 105, 115 and 125 V on T103

20 watts

Source Impedance

600 ohms balanced when shipped; may be reconnected for 150-ohm balanced or unbalanced source

Input Impedance

Matching
600 ohms when shipped; may be reconnected for 150 ohms

Bridging
20,000 ohms

Load Impedance

600 ohms when shipped; may be changed to 150 ohms

Maximum Input Level

Matching —20 dbm
Bridging +18 dbm

Maximum Output Level

+30 dbm

Harmonic Distortion

0.5% rms maximum at 30 dbm output, 30 to 15,000 cps

Matching Gain

70 ± 1 db high gain strapping (as shipped)
55 ± 1 db low gain strapping

Bridging Gain

33 ± 2 db high gain strapping
18 ± 2 db low gain strapping

Frequency Response

Better than ± 1 db, 30 to 15,000 cps
(Referred to 1000 cps)

Noise Level at Output

—47 dbm max. high gain strapping, 30 to 15,000 cycles

—62 dbm max. low gain strapping, 30 to 15,000 cycles

Transistor and Diode Complement

2 — 2N1010
2 — 2N526
3 — 2N553
4 — 1N2069

Overall Dimensions

Height—$4\frac{21}{32}$ inches
Width—5 inches
Depth—$11\frac{3}{16}$ inches (chassis)
13 inches (overall)
Weight—10 pounds

Mounting

Plug-in mounting on MI-11597-A Mounting Shelf, Type BR-22B; three units may be mounted on one shelf. Units may also be mounted on the MI-11597, BR-22A Shelf. (See Description.)

DESCRIPTION

The Type BA-33A Program Amplifier, MI-11446, an all transistor unit with a self-contained power supply, is designed for use as a program or line amplifier, bridging or isolation amplifier. The BA-33A with its guide assembly may be plug-in mounted on a BR-22B Mounting Shelf. Up to three BA-33A units and one BA-31A unit may be mounted on one shelf. The same number of units may be mounted on the MI-11597, Type BR-22A shelf when angle brackets at the rear of the shelf are removed.

Equipment Supplied

Qty.	*Unit*	*MI-Number*
1	Program Amplifier	MI-11446
1	Guide Assembly	
2	Connectors	
1	Container with mounting hardware	
1	Instruction Book	IB-24820-1

Accessories (Not Supplied)

Qty.	*Description*	*MI-Numbers*
1	Mounting Shelf, Type BR-22B for BR-84 Rack mounting; 5¼ inches vertical space required mounts 3 BA-33A and 1 BA-31A unit	MI-11597-A
1	Attenuator, 20 steps, 2db per step, 5000 ohms	MI-11751-5
1	Spare Transistor and Diode Kit, for BA-33A	MI-11781

Guide Assembly

As shown in figure 1, a guide assembly is supplied with each BA-33A amplifier for mounting the unit on the BR-22B Mounting Shelf. The guide assembly bolts onto the shelf and holds the bracket for mounting the connectors supplied separately with the necessary hardware. Refer to the *Installation* for the assembly procedure.

Circuit Description

The BA-33A Program Amplifier consists of an input transformer, a two-stage feedback preamplifier, a feedback output amplifier with two stages mounted on the etched wiring board PW1 and three stages mounted on the chassis, a gain control, an output transformer and a power supply. Refer to the Simplied Schematic, figure 4.

A signal fed to the input transformer flows from the secondary into the base of Q1, a common-emitter amplifier. The amplified signal flows out the collector of Q1 to the base of Q2, also a common-emitter amplier, where it is further amplified and flows through R10, the collector load resistor.

Feedback current flows from Q2 to Q1 by two paths or loops. The first loop is through C6 and R4 to the base of Q1. This negative feedback loop tends to *lower* the input impedance. The second loop is through R9 to R6 of the first stage. This negative feedback loop tends to *raise* the input impedance. The relative amounts of feedback are adjusted for a 150/600 ohm input impedance. The output of this two-stage preamplifier flows through C9 to the gain control R108.

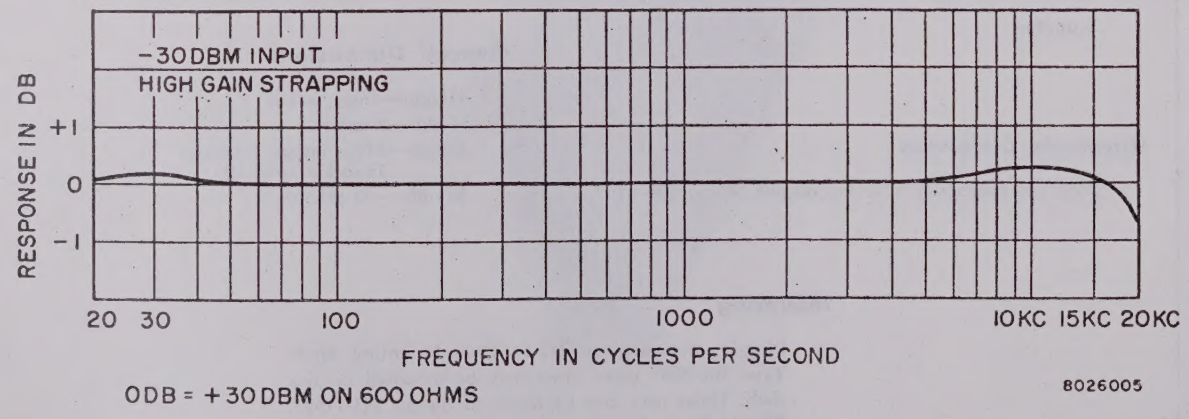


Figure 2—Typical Frequency Response

The feedback output amplifier functions as follows: The first stage Q3 is a common-emitter amplifier. The input signal applied to its base is amplified, flows out the collector, and is capacity-coupled to Q4, also a common-emitter amplifier. Q4 amplifies the signal current and develops a voltage across R26, the collector load resistor. This signal voltage is direct-coupled to Q101, an emitter-follower. The voltage at the emitter of Q101 is at a low impedance, and is in phase with the voltage at the base of Q101. The same holds true for Q102. Feedback current flows from the emitter of Q102 through R24 and C19 to the emitter of the first stage Q3. This loop is the 3rd FB loop in figure 4. For the low gain connection, terminals 55 are joined and additional feedback current flows back through R25 and C20. Also, terminals 70 are opened to insert R29 in the emitter of Q4. Resistor R29 supplies enough *local* feedback to prevent the amplifier from oscillating when the extra *loop* feedback of R25 is added.

The power output stage consists of Q102 and Q103. Q102 is an emitter follower which is fairly linear. The linearity is improved by Q103. A small resistor in the collector of Q102 couples some signal to the base of Q103, a common-emitter amplifier. The signal developed at the collector of Q103 is in

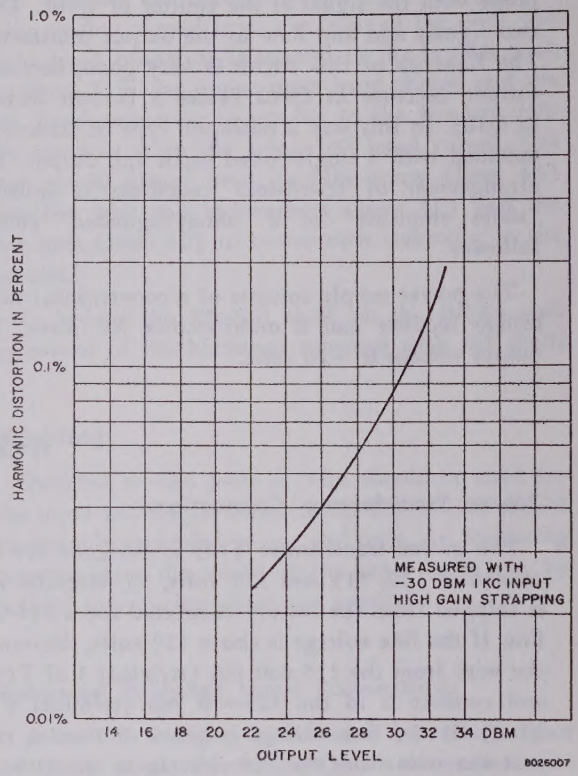


Figure 3—Typical Distortion Curve

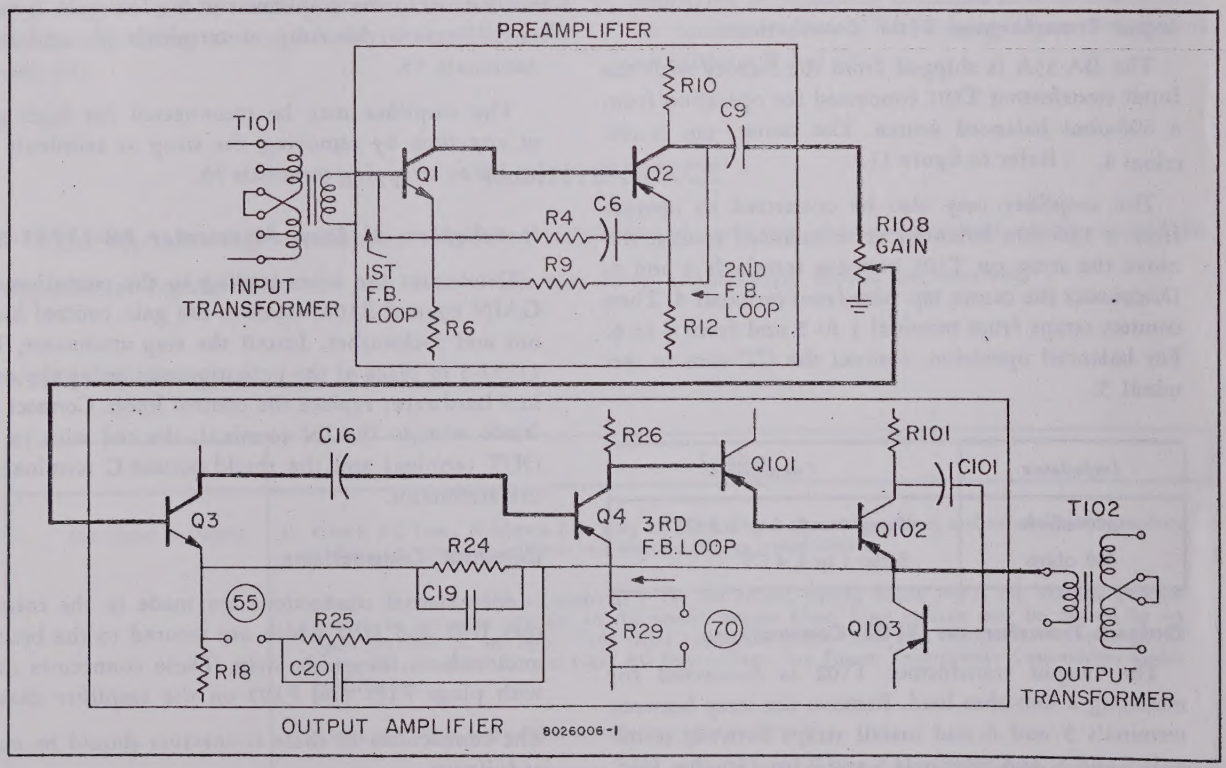


Figure 4—Simplified Schematic

phase with the signal at the emitter of Q102. These two signals add and flow to the output transformer. The linearity of this circuit is very good, because a current decrease in Q102 causes a current increase in Q103. In this way a push-pull type of linearity is obtained with a single-ended input and output. This arrangement of transistors sometimes is called a "series amplifier" or a "shunt-regulated" emitter follower.

The power supply consists of a conventional diode bridge rectifier and a multi-section RC filter. The output voltage is −26 volts.

The component symbol designation varies in series according to the physical location of the component as follows:

Location of Component	*Symbol Series*
PW1 Etched Wiring Board (Top of Chassis)	1 - 100
Chassis Mounted	101 - 200

INSTALLATION

Power Transformer Connections

The power transformer T103 is designed for operation at 105, 115 and 125 volts, 50/60 cycles and is shipped from the factory connected for a 115-volt line. If the line voltage is above 120 volts, disconnect the wire from the 115-volt tap (terminal 3 of T103) and connect it to the 125-volt tap (terminal 4 of T103). If the line voltage is below 110 volts, connect the wire from the 115-volt tap to the 105-volt tap (terminal 2 of T103).

Input Transformer T101 Connections

The BA-33A is shipped from the factory with the input transformer T101 connected for operation from a 600-ohm balanced source. The center tap is terminal 4. Refer to figure 11.

The amplifier may also be connected to operate from a 150-ohm balanced or unbalanced source. Remove the strap on T101 between terminals 3 and 4. Disconnect the center tap wire from terminal 4. Then connect straps from terminal 1 to 3 and from 4 to 6. For balanced operation, connect the CT wire to terminal 5.

Impedance	*Connection*
150 ohms	Strap 1 to 3, 4 to 6, 5 CT
600 ohms	Strap 3 to 4, 4 CT

Output Transformer T102 Connections

The output transformer T102 is connected for matching a 600-ohm load. Remove the strap between terminals 5 and 6 and install straps between terminals 4 and 5, and terminals 6 and 7 for 150-ohm load.

Impedance	*Connection*
150 ohms	Strap 4 to 5, 6 to 7
600 ohms	Strap 5 to 6

Gain Connections

The BA-33A is shipped connected for high-gain operation, that is, 70 db of matching gain with the gain control wide open. If less than 55 db gain is needed, strap the amplifier for the low gain connection. Remove the strap at terminals 70, and strap terminals 55.

The amplifier may be reconnected for high gain at any time by removing the strap at terminals 55, and then strapping terminals 70.

Installation of Step Attenuator MI-11751-5

Disconnect the wires leading to the potentiometer GAIN control R108. Remove the gain control knob, nut and lockwasher. Install the step attenuator, MI-11751-5 in place of the potentiometer, using the original hardware; replace the control knob. Connect the black wire to the IN terminal, the red wire to the OUT terminal and the shield to the C terminal on the attenuator.

External Connections

All external connections are made to the connectors J101 and J102 which are secured to the bracket mounted on the guide strip. These connectors mate with plugs P101 and P102 on the amplifier chassis.

The connections to these connectors should be made as follows:

Function	*Terminals*
J101	
Input (matching)	A and C
600 ohms	Strap 3 and 4 (CT4) on T101
150 ohms	Strap 1 and 3, 4 and 6 (CT3) on T101
Center Tap	E
Input (Bridging)	B and D (Strap A to H and C to F)
J102	
Output	F and H
600 ohms	Strap 5 to 6 on T102
150 ohms	Strap 4 to 5, 6 to 7 on T102
Power Line	B and C
Ground	A

Mounting Guide Assembly on BR-22B Shelf

A guide assembly is supplied with each amplifier for mounting on the BR-22B mounting shelf. The guide assembly bolts on to the mounting shelf. The connectors are secured to the brackets welded on the guide strip. The mounting procedure is as follows:

1. Place the guide assembly on the BR-22B Mounting Shelf so that the bracket is at the far or rear end of the shelf and extends upwards.

2. Secure the guide assembly to the mounting shelf with the two #6-32 machine screws (Item 4C) and the corresponding nuts and lockwashers (Items 4D and 4F).

3. Position the two connectors (Item 3) horizontally, so that viewed from the front of the shelf, the right hand connector is secured to the bracket with terminal A in the upper right hand corner and the left hand connector is secured to the bracket with the terminal A in the lower left hand corner. Use two #4-40 filister head machine screw (Item 4A) together with the lockwashers (Item 4E) and the hex nuts (Item 4B) to secure each connector to the bracket.

4. Mount the BR-22B shelf on the BR-84 rack by means of the hardware supplied with the shelf.

Shielding

Shielded twisted pairs of wire should be used for the input and output connections. The shields should be securely grounded at one end only. An insulating covering over the shield of the input leads may be helpful in reducing noise and crosstalk.

Balanced Bridging Input Connections

A built in bridging pad has an input impedance of 20,000 ohms and reduces the maximum insertion gain by 37 db when connected. The pad may be connected by strapping terminals A to H and C to F on connector J101. The bridging input connections on J101 are B and D.

MAINTENANCE

The BA-33A Program Amplifier requires a minimum of servicing. Components and wiring should be inspected at regular intervals. Any dust which may have accumulated should be removed.

Trouble Shooting

Problem	*Solution*
No signal at output	1. Check AC fuse: A blown fuse may be caused by a shorted rectifier, a shorted filter capacitor, a short on the —26 volt bus or a shorted power transformer. 2. Check for —26 volts at terminal P on the etched wiring board PW1. No voltage may be caused by an open resistor in the power supply filter. Low voltage may be caused by an open rectifier or by open C105 filter capacitor. Make sure that the power transformer is properly connected for the local AC line voltage. See *Power Transformer Connections* under *Installation.* 3. Check the input and output transformers for continuity.

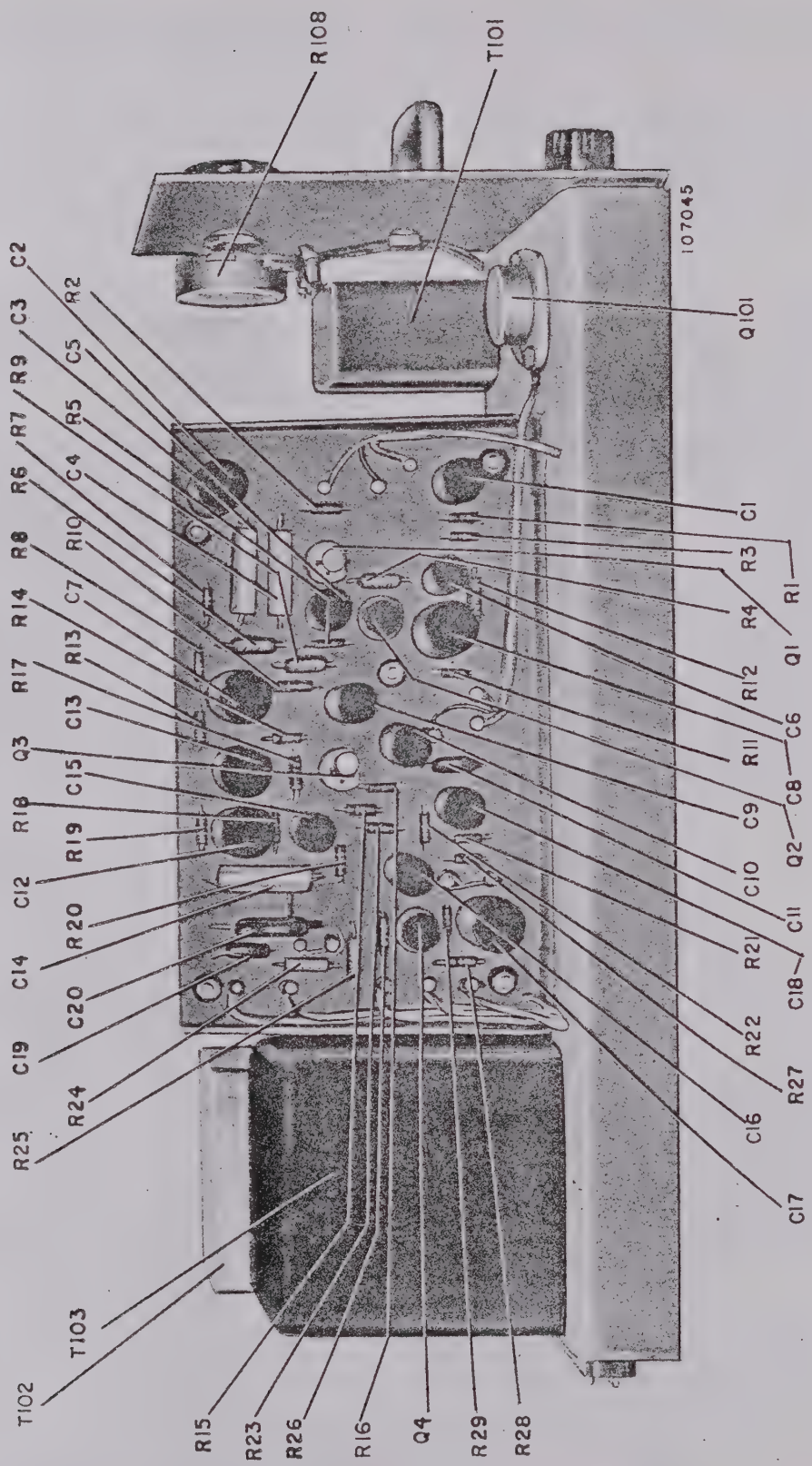


Figure 5—Program Amplifier Side View Showing Etched Wiring Board PW1

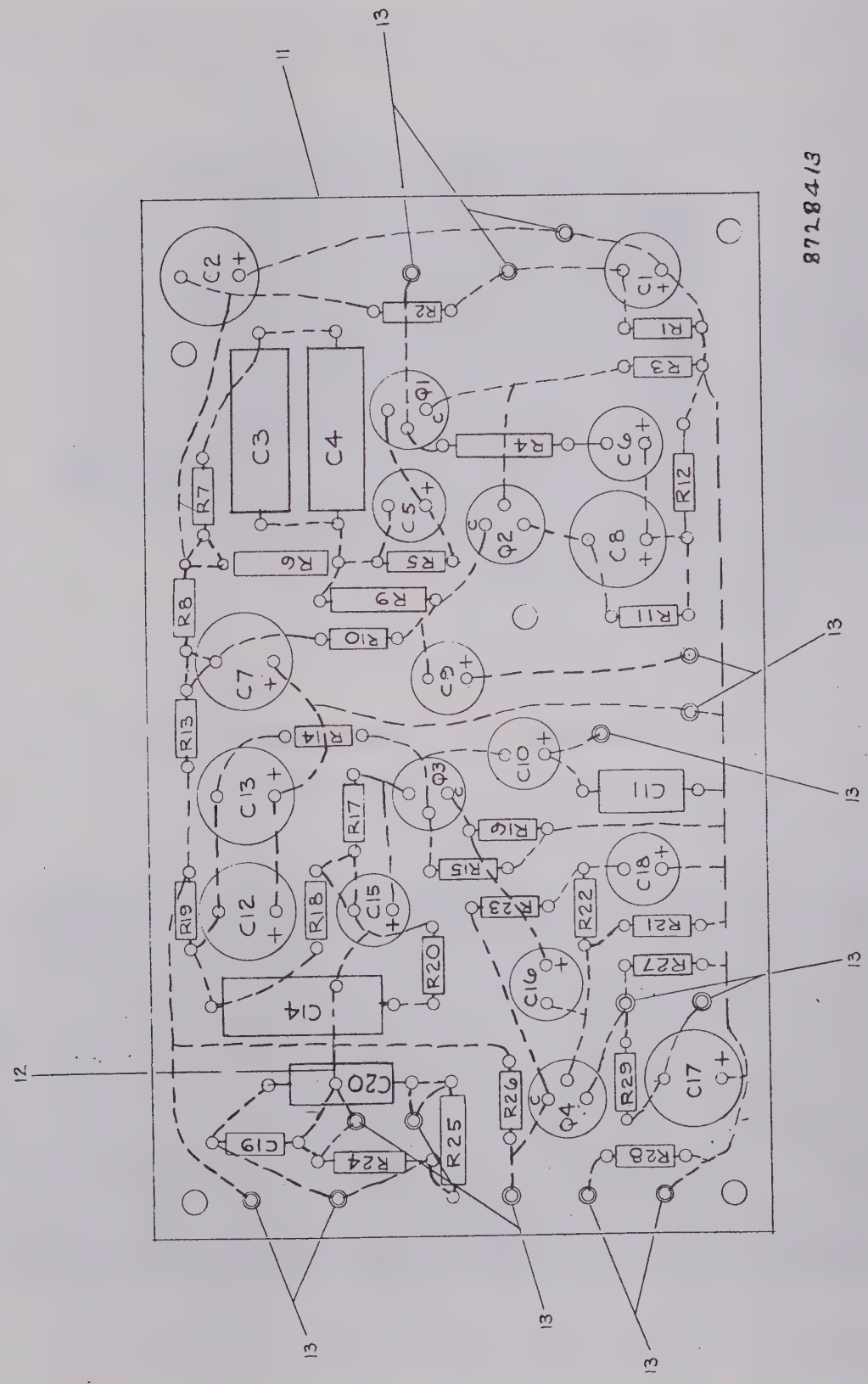


Figure 6—Component Assembly on Etched Wiring Board Showing Circuitry

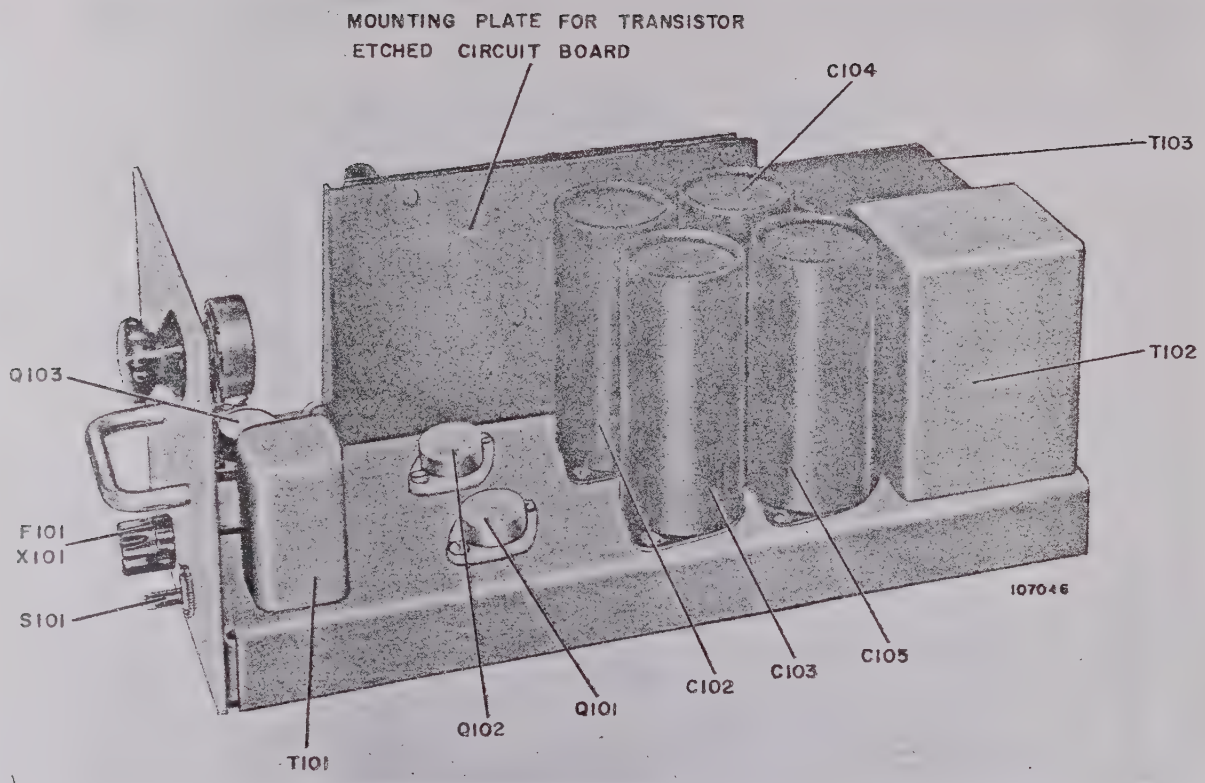


Figure 7—Program Amplifier Side View Showing Chassis Mounted Components

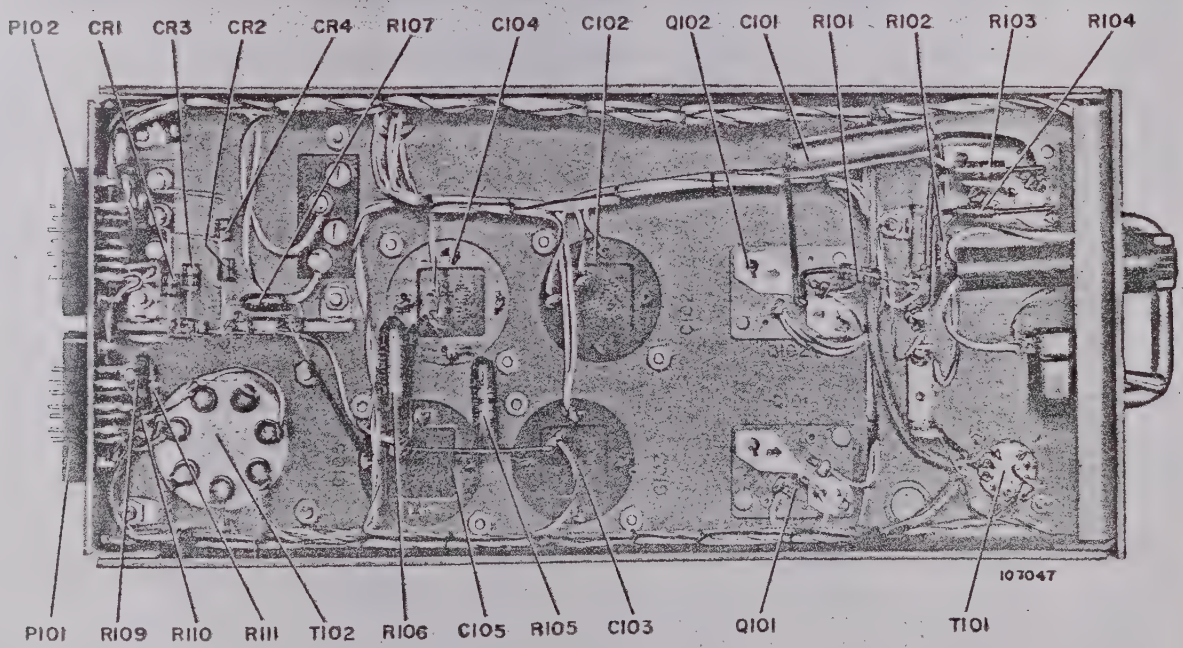


Figure 8—Program Amplifier Bottom View

Problem	*Solution*
No signal at output	4. Check connectors for broken wires. 5. Apply a signal, about —30 dbm, to the input and check for the signal at the GAIN control: If *no signal* appears, the trouble is in the preamplifier stage. Check the d-c voltages. If the *signal appears* at the GAIN control but not at the output, the trouble is in the output amplifier. Check the d-c voltages in the amplifier output.
Hum on the output	1. Experience shows that in new installations most hum is caused by ground loops. For example, if one side of the source and one side of the amplifier are grounded, a ground loop exists. It is normal practice to ground the center-tap of the input transformer for balanced lines. If unbalanced lines and circuits are used, it is normal practice to ground the low side of the line at the input transformer and to have no grounds at the source. 2. If the amplifier is mounted in a strong magnetic hum field, the input transformer may pick up some hum. Avoid mounting low-level audio amplifiers near strong hum fields, such as motors, replacement-type power transformers, and low-priced transformer-operated electronic equipment.
Low gain or high gain	1. Make sure that the amplifier is properly strapped for the desired gain as described under *Gain Connections* in the *Installation* procedures. 2. Make sure that the input and output transformers are properly strapped. 3. Make sure that the input line is not grounded on one side at the same time the input transformer center tap is grounded; this combination of ground connection would short out half of the input transformer.

Replacement of Transistors

To replace transistors Q1 through Q4, turn off the power, wait one minute; then remove the old transistor and replace it with a new one.

CAUTION: Never replace a transistor with the power ON. The heavy surge currents may damage it. Always wait one minute before removing transistors. Remove all transistors before making ohmmeter tests.

Transistors Q101, Q102, Q103 are secured to the chassis by self-tapping screws. To replace these transistors remove the two screws, pull each transistor out of its socket and remove the thin mica washer insulating the transistor from the chassis. Save the washer. If necessary, trim the leads of the new transistor to the $\frac{7}{16}$-inch. Place the washer on the transistor and insert the transistor in its socket. Make sure that the screws will clear the chassis; the screws must not contact the chassis. Then replace the screws. If the fuse blows, one of the transistor mounting screws is probably shorting to the chassis.

Replacement of Components on Etched Wiring Board

As may be seen in the side view of the chassis, figure 5, and in the component assembly diagram figure 6, the BA-33A Amplifier has an etched circuit board on one side of which numerous components are mounted and on the reverse side the etched circuitry.

If it is necessary to isolate a component to determine the source of trouble, loosen one of the component leads. This should be done by melting the solder surrounding the lead; be sure to use a small 25-watt soldering iron as a higher wattage iron may cause the copper to peel from the board. With long-nosed pliers straighten the bent over portion of the lead before pulling it through the hole from the component side. If the component is found to be in good condition, reverse the above procedure. Be careful not to damage the copper foil by applying too much heat or force.

Should it be necessary to replace the circuit components for failure, proceed as follows:

1. Isolate the defective component

2. To remove the component, snip the lead off at the component side of the board. Refer to figure 9.

3. Using a small soldering iron (25w), heat the leads and remove them from the etched wiring side of the board. Be careful not to apply too much heat or force to avoid damage to the thin etched conductors.

4. Clean and preform the leads of the new component and insert them through the holes until the component body is tight against the board.

5. On the circuit side, grasp the component lead and bend it over in the direction of the circuit pattern.

6. Crimp the wire tightly against the board (see figure 9) and cut off the excess component lead. Leave about $\frac{1}{16}$ inch of wire protruding from the edge of the hole.

7. Heat the lead and apply rosin core solder. DO NOT USE PASTE OR ACID FLUX. Remove excess rosin from the joints with alcohol.

8. Replace the etched board on the amplifier chassis using the original hardware.

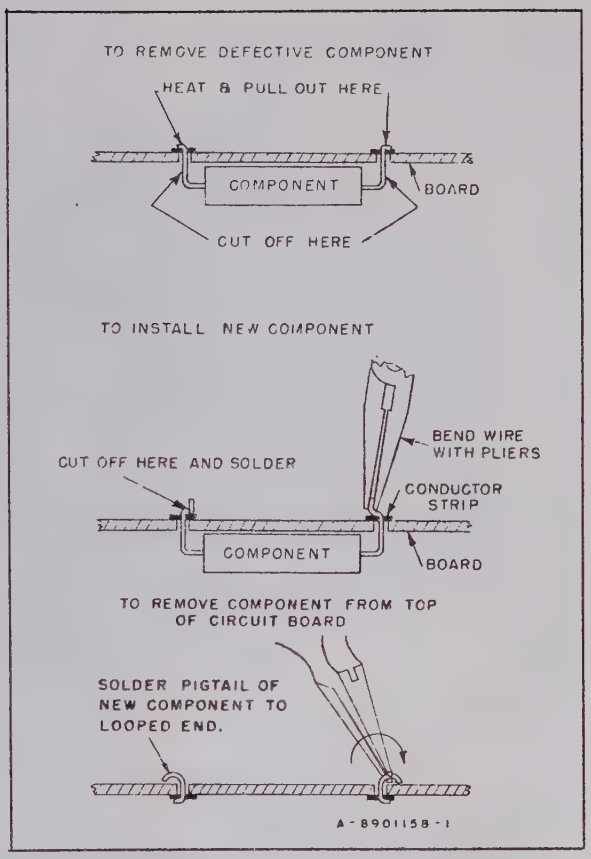


Figure 9—Methods of Replacing Components on Etched Wiring Board

Noise Measurement

The output noise of the BA-33A amplifier is rated as −47 dbm (or −62 dbm for low-gain operation). This rating is based on a 15 kc bandwidth. Most test equipment, and this amplifier, have a bandwidth greater than 15 kc. In order to measure the true noise, it is necessary to connect a filter between the amplifier and the measuring equipment. A suitable filter is shown in figure 10.

With the filter connected as shown, the noise level at the filter output should be less than −53 dbm

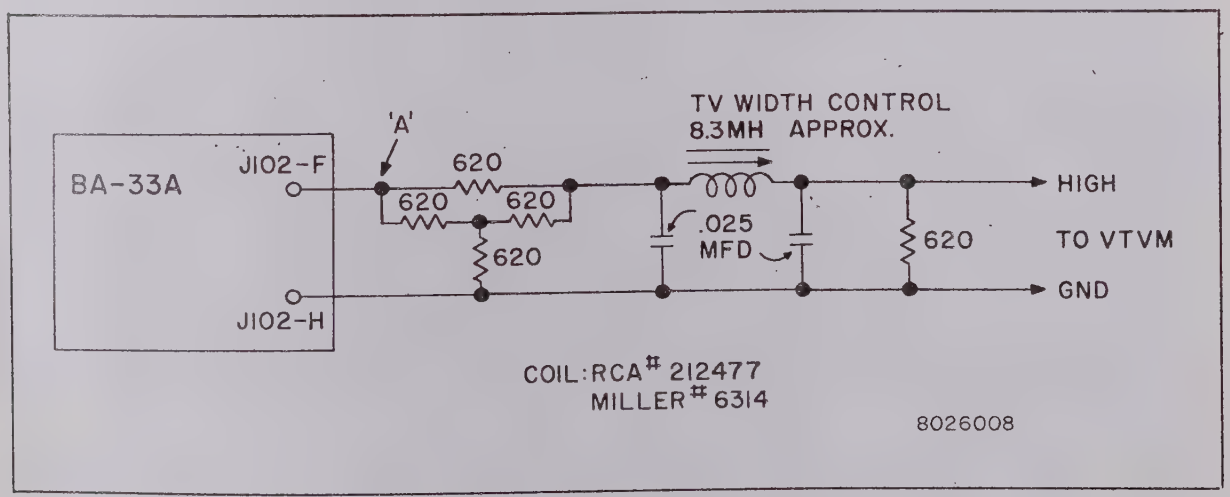


Figure 10—15KC Cut-off Filter, Used for Noise Measurement

(1.7 millivolts) with the high-gain connection, or −68 dbm (0.3 millivolts) with the low-gain connection. Be sure to orient the coil to avoid picking up hum.

An easy way to adjust the filter is to disconnect point "A" from the amplifier and connect it to the 600-ohm terminals of an oscillator. Adjust the coil for 1 db loss at 15 kc, referred to 1 kc. With this adjustment, the noise bandwidth of the filter is about 18 kc. Note that the filter is used only for noise measurements, not ordinary operation.

This method of measurement is in accord with FCC and EIA requirements.

Voltage Measurements

The voltages in the following table are typical values. They were measured with a 20,000-ohm per-volt meter between the transistor socket and chassis ground, under *no signal* conditions.

	Collector	*Base*	*Emitter*
Q1	−3.1	−7.0	−7.7
Q2	−15	−3.1	−3.0
Q3	−1.4	−4.2	−4.5
Q4	−13	−2.1	−2.0
Q101	−26	−13.1	−13.2
Q102	−24.4	−13.2	−13.0
Q103	−13.0	−2.1	−1.8

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			CAPACITORS: Fixed unless otherwise specified
C1	221658	8511028-310	Electrolytic: 20 μf, 15 v
C2	221560	8511028-414	Electrolytic: 70 μf, 25 v
C3, C4		990786-263	Film: 0.01 μf ±10%, 200 v
C5, C6	221659	8511028-308	Electrolytic: 10 μf, 15 v
C7	221560	8511028-414	Electrolytic: 70 μf, 25 v
C8	221660	8511028-18	Electrolytic: 250 μf, 3 v
C9	221659	8511028-308	Electrolytic: 10 μf, 15 v
C10	221661	8511028-211	Electrolytic: 25 μf, 12 v
C11		8914319-343	Mica: 620 μμf ±5%, 300 v
C12, C13	221560	8511028-414	Electrolytic: 70 μf, 25 v
C14		990786-265	Film: 0.015 μf ±10%, 200 v
C15	221661	8511028-211	Electrolytic: 25 μf, 12 v
C16	221417	8511028-408	Electrolytic: 10 μf, 25 v
C17	221660	8511028-18	Electrolytic: 250 μf, 3 v
C18	221659	8511028-308	Electrolytic: 10 μf, 15 v
C19		8914319-336	Mica: 330 μf ±5%, 500 v
C20		8924416-314	Mica: 1500 μμf ±5%, 500 v, Char. F
C101	108020	8959154-114	Electrolytic: 100 μf, 25 v
C102 to C105	218720	458558-54	Electrolytic: 1500 μf, 50 v
CR1 to CR4	218612		Rectifier: diode
F101	218628	990157-107	Fuse: .75 amp. slo-blow
P101, P102	221561	8448847-1	Connector: male, 7 contact
PW1 was 229943 #105	~~221662~~	8511067-501	Circuit: printed, complete with components
Q1	224820		Transistor: type 2N1010
Q2	221663		Transistor: type 2N526
Q3	224820		Transistor: type 2N1010
Q4	221663		Transistor: type 2N526
Q101 to Q103	219940		Transistor: type 2N553
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1, R2		722300-191	22,000 ohm ±5%, ¼ w
R3		722300-75	12,000 ohm ±10%, ¼ w
R4	221664	990724-337	Film: 2370 ohm ±1%, 1/8 w
R5		722300-191	22,000 ohm ±5%, ¼ w
R6	221665	990724-261	Film: 422 ohm ±1%, 1/8 w
R7		722300-135	100 ohm ±5%, ¼ w
R8		722300-188	16,000 ohm ±5%, ¼ w
R9	221666	990724-377	Film: 6190 ohm ±1%, 1/8 w
R10		722300-168	2400 ohm ±5%, ¼ w
R11		722300-155	680 ohm ±5%, ¼ w
R12	221667	990724-201	Film: 100 ohm ±1%, 1/8 w
R13		722300-150	430 ohm ±5%, ¼ w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R14		722300-194	30,000 ohm ±5%, ¼ w
R15		722300-187	15,000 ohm ±5%, ¼ w
R16		722300-163	1500 ohm ±5%, ¼ w
R17		722300-182	9100 ohm ±5%, ¼ w
R18		722300-135	100 ohm ±5%, ¼ w
R19		722300-184	11,000 ohm ±5%, ¼ w
R20		722300-155	680 ohm ±5%, ¼ w
R21		722300-175	4700 ohm ±5%, ¼ w
R22		722300-179	6800 ohm ±5%, ¼ w
R23		722300-187	15,000 ohm ±5%, ¼ w
R24	221668	990724-349	Film: 3160 ohm ±1%, 1/8 w
R25	221669	990724-277	Film: 619 ohm ±1%, 1/8 w
R26		722300-161	1200 ohm ±5%, ¼ w
R27		722300-142	200 ohm ±5%, ¼ w
R28		722300-166	2000 ohm ±5%, ¼ w
R29		722300-135	100 ohm ±5%, ¼ w
R101	217248	8955299-26	W.W., 5 ohm ±10%, 3 w
R102		90496-159	1000 ohm ±5%, 1 w
R103		82283-135	100 ohm ±5%, ½ w
R104	217248	8955299-26	w.w., 5 ohm ±5%, 1 w
R105	55052	8926264-11	W.W., 20 ohm ±10%, 5 w
R106	210449	8926264-10	W.W., 15 ohm ±10%, 5 w
R107	219943	8955299-21	W.W., 1 ohm ±10%, 3 w
R108	220947	758505-3	Variable: 5000 ohm ±10%, 2 w
R109		82283-74	10,000 ohm ±10%, ½ w
R110		88223-154	620 ohm ±5%, ½ w
R111		82283-74	10,000 ohm ±10%, ½ w
S101	48791	187454-1	Switch: toggle, S.P.S.T.
T101	221552	8449553-1	Transformer: input
T102	221671	8446106-1	Transformer: output
T103	221672	8448876-1	Transformer: power
XF101	48894	99088-2	Holder: fuse
XQ1 to XQ4	218767	8707294-37	Socket: transistor
XQ101 to XQ103	219949	8975560-2	Socket: transistor
			Miscellaneous:
	30075	737820-507	Knob: control
	206007	85549-8	Cover: insulating, for C102 to C105
	219950	8975572-2	Insulator: mica, for Q101 to Q103
	221562	8448847-2	Connector: female, 7 contact

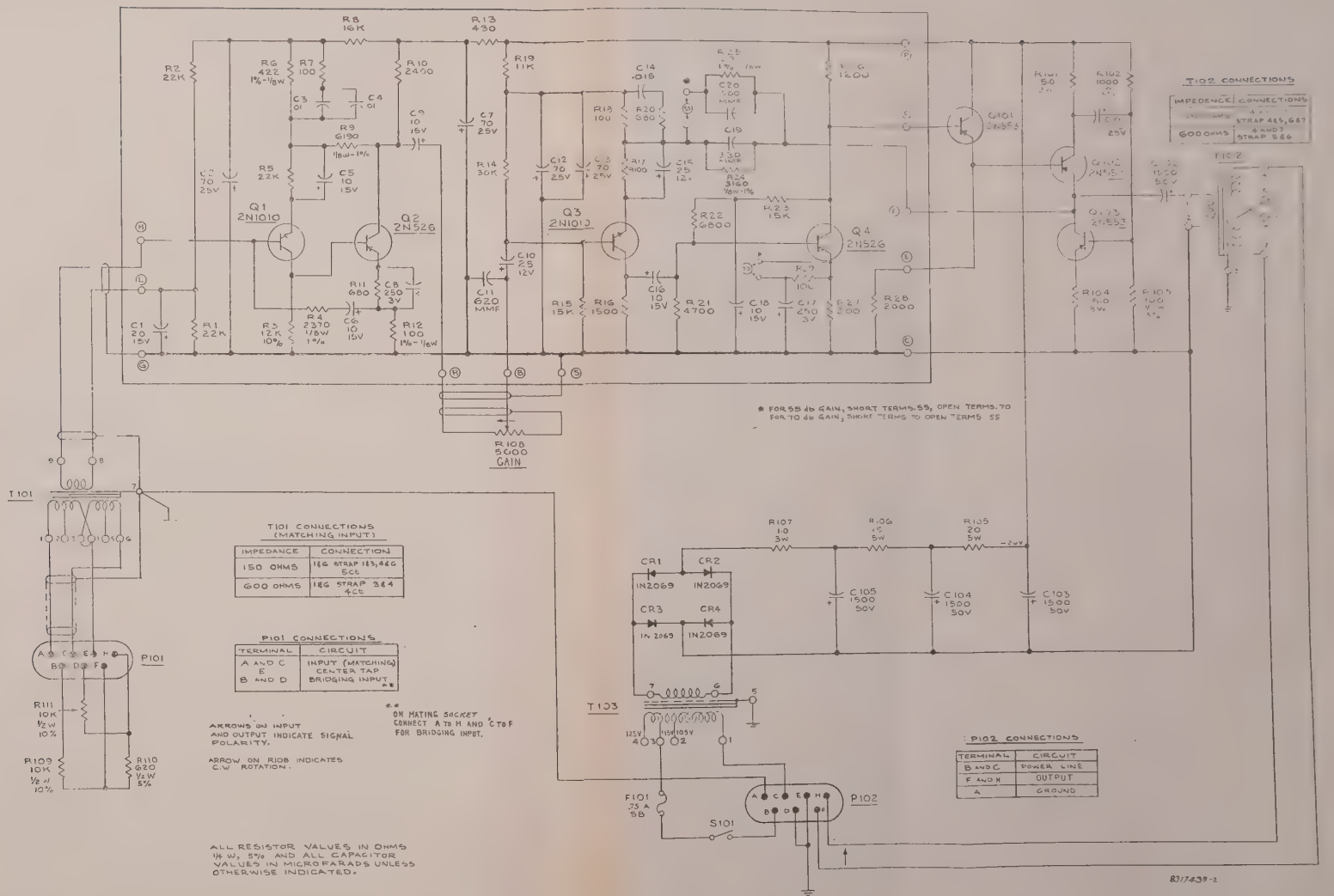


Figure 11—Schematic Diagram

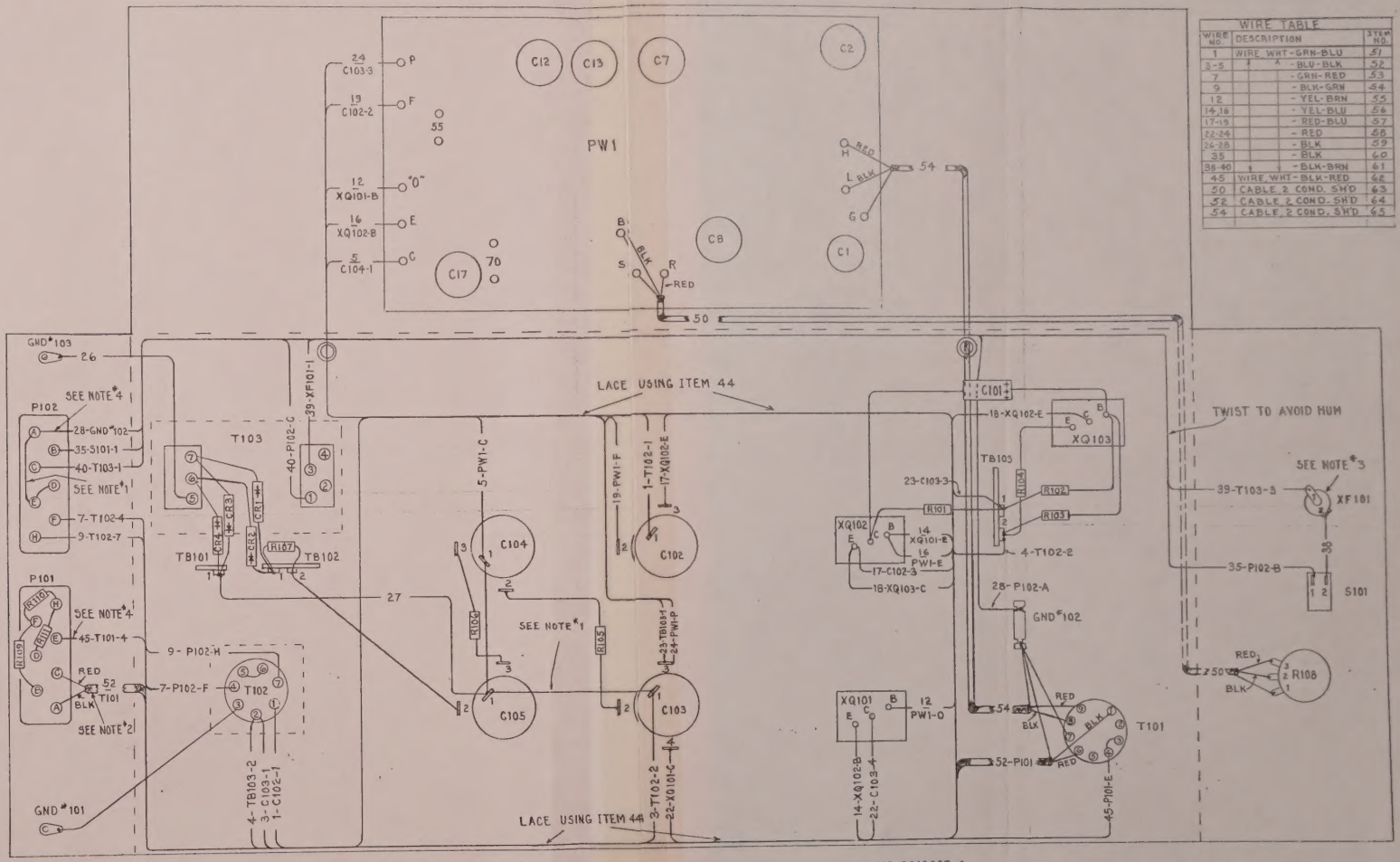


Figure 12—Connection Diagram

No. 525
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KANKAKEE, ILL.